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ABSTRACT

Cognitive aging research needs to clarify whether or not there are functional or ability declines with aging and, if so, to understand and mediate these declines. Recent research which has demonstrated declines in cognitive functioning with age has involved episodic memory and rehearsal-independent forms of such memory. It is not known how much of this decline can be attributed to physiological, sociocultural, or experiential factors. Continuing, if not increasing, productivity with aging occurs in performance areas requiring expertise such as mathematics or the arts. Tasks that do not require expertise, such as finger tapping, are often used in psychological research. Expertise tasks tend not to be measured in developmental research. Some research has shown paradoxical results for functional skills tests. Although older people were slower at component skills of a task, they were equal in overall task performance. This suggests limitation in the kind of measurement commonly used in cognitive research. It is not known whether expert performance is maintained by compensatory strategies or whether the present componential analysis is incorrect. (ABL)

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Cognitive Aging Research: What does it say about cognition? Aging?

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An Outside Perspective

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Cognitive Aging Research: What does it say about Cognition? Aging?

Bob Bjork and I were asked to give informal reflections on cognitive aging research from the perspectives of an outsider. Professionally, I am an outsider. While I have done some developmental research, it has been exclusively with younger people, primarily with preschool children. I have not been actively involved in research with older populations, nor am I familiar with the literature on aging and age-related changes in cognitive skills, abilities or capacities. Partly this is because one can't really keep up with everything, even in one's own specific field, but partly I figure that with patience and time I'll learn all about the effects of aging in due course. With the fullness of time, I won't have to learn about it second-hand, I'll simply experience it and hope I retain enough of the requisite cognitive skills to notice and understand what's happening.

This last remark betrays a bias that is prevalent not only among outsiders but also within the field of gerontology and aging. The presumption seems to be that only declines in functioning and abilities are to be found with aging, and once we have documented the specific declines, the next step is to understand the processes and mediators of those age-related declines...perhaps to help develop remediation, perhaps to understand more about cognition in general.

Cognitive aging research - to an outsider at least - seems to fall into two general categories. The first takes aging as intrinsically interesting, and asks, what happens with age? The second category seems not so much interested in aging per se, but instead tries to exploit or use aging populations as a special preparation - just as children and clinical patient populations are used. Indeed, the use of "abnormal" populations is not restricted to special kinds of people. When we use any kind of degraded or distorted input to normal people, we are in effect stressing the system

to its breaking points and trying to learn about its normal operation thereby. Examples from classical experimental psychology abound: tachistoscopic presentation of visual stimuli, speech in noise, speeded tasks of all kinds. The logic is standard in psychology: we can learn some of the characteristics of complex systems by observing those systems under degraded or stressed conditions. Characteristic patterns of performance breakdowns may provide insights into the normally operating system.

My remarks today will touch briefly on these two foci of interest: what happens with age, and the use of aging populations for theoretical purposes. These two foci are not unrelated, of course. The first provides suggestions for how aging populations might be useful for theoretical purposes; the second can provide suggestions as to what kinds of changes to look for in aging...in particular, when one might expect not only declines but also improvements in performance with age. I'll try to be more specific about this after I reflect on the first area of research, what happens with age? What have we to look forward to, if anything?

On what happens when? Is it all downhill?

The good news first. According to at least some people in the field, cognitive abilities need not decline with age. Schaie (1979), using overlapping longitudinal designs, provides encouraging evidence that intellectual ability need not decline until, perhaps, the late sixties. Even better, his data seem to show that ability increases up to the late sixties, and better yet, Botwinick & Siegler (1980) found no declines until age 75, provided that one is both active and healthy (two not entirely unrelated states of affairs). It is worth noting that such findings depended upon a keen appreciation of cohort effects and the need to develop techniques that permit longitudinal sampling within the investigator's own working lifetime.

One problem with long-term developmental work is that it does take time..., and to study changes over a lifetime requires a lifetime. Cross-sectional studies are intrinsically vulnerable to cohort (or secular) effects. This is particularly true when intellectual performances are involved because of the tremendous change in information and communication resources over the last several decades. To say that there has been an information-communication explosion in the last 50 years is not hyperbole. Successive generations have had increasing access to information via the media - television, radio - and increasing opportunities for education (e.g., the community college movement). Cross-sectional measures of general intellectual ability under these circumstances must show lower performance in older groups, if we simply assume that access to information and education contribute to those scores and also assume that in any given group there is no underlying cognitive decline. The introductions of such techniques as the overlapping longitudinal design is a contribution not only to aging research, but to developmental research in general. Not only does it give those of us approaching late middle age some comfort about our own perhaps-not-so-declining powers, but it also gives us a tool with which we can trace long-term developmental trends in a relatively short and tractable time.

But all is not rosy. The overwhelming bulk of research on aging reports declines in cognitive functioning with age, at least with garden-variety laboratory tasks. To cite the most recent example that I've come across, several reports of cognitive processes in the aged were given at a symposium held at the 13th International Congress of Gerontology this last July. Professor Kausler, our discussant, described studies in his laboratory that showed age deficits not only in those forms of episodic memory that require rehearsal, but also in rehearsal-independent forms of

such memory (Kausler, 1985). Winocur (1985), in the same symposium, describes memory loss with age in both people and laboratory rats, attributing at least some of this decline to hippocampal dysfunction. Patrick Rabbit (1985), aptly summarizes the field, going beyond memory deficits:

> "Research examining the development of cognitive processes in adulthood has clearly shown that age differences in performance are widespread. Much of the work has focused on demonstrating the existence of such differences (with older usually worse, of course). More recently attention has been focused on the processes and mediators of such age-related effects" (p. 67).

But this raises at least two questions. The first is obvious: granted that there are declines with age, how much of such decline (in any cognitive ability), or specifically what forms or processes of decline, are attributable to physiological factors, and what is attributable to socio-cultural and experiential factors? Within physiologically mediated effects, what is attributable to normal aging, what to ill health and accidents? Within the range of socio-cultural and experiential factors, which are purely "experiential", and which are mediated by physiological effects of experience. To bring a note of optimism in at this point, a recent issue of the New York Times described research with elderly rats. Those who lived in a stimulating, rich environment showed increased thickening of cortex and lengthening of dendrite tips. If "cerebral exercise" is effective for people, then perhaps we can look forward to the intellectual equivalent of jogging and running. Instead of a 3 mile run every morning, perhaps an intensive game of scrabble or not-so-trivial pursuit?

This brings me to the second focus of interest, the use of research on aging for more general theoretical purposes. As interesting and important

as the straightforward questions about aging are, they are not as interesting to cognitive psychologist outsiders as the theoretical questions that are raised by a somewhat paradoxical phenomenon, namely, the sparing of complex cognitive functions when, for all intents and purposes, the abilities that presumably underly those functions are individually declining...wasting away with age.

What I'm referring to has been known for a long time in such fields as music, the arts, literature, science - those fields where it takes a long time to develop expertise and craft and skill. In each of these fields there are people who just go on and on, if anything improving with age. Pablo Picasso, Andres Segovia, Vladimir Horowitz, Claudio Arrau, Rudolf Serkin, Isaac Stern. The myth of the loss of creative power with age in mathematics and science is just that - a myth. Granted, there is precocious contribution and performance in such fields as mathematics, but the overwhelming preponderance of important work is done by the more experienced and mature scientists and mathematicians. This apparently rare phenomenon - continuing productivity into late middle age and old age - may not be so rare, and may not be confined to the very talented and creative. Instead, such apparent "sparing" may be representative of a general class of performances that I'll refer to as "expertise". Contrast tasks that require expertise with those that do not: Those that do not are the kind typically used in psychological research: simple and choice reaction time, finger tapping, speed of lexical decisions, memory tasks of various kinds, and so on. Those tasks that require expertise tend not to be used in developmental research, partly because the expertise requires a long time to develop - at least ten years for chess, for example. When such tasks are used, then the surprising finding seems to be no decline with age.

Two recent examples merit brief consideration. In the July symposium on cognitive processing in the aged, Neil Charness gave an atypical

paper...one that, along with the others, showed declines in functioning with age, but that also posed the paradox that I find interesting - no decline in a complex task that presumably draws upon those component processes that do individually decline with age. Charness studied people who varied in age and skill levels. To avoid misrepresenting him, I'll simply read his abstract to you:

> In 3 studies, performance in knowledge dependent tasks was contrasted with that for more typical cognitive tasks. Bridge players varying in age and skill level (N=45), performed full and partial bridge bidding tasks, reaction time, memory, and problem-solving tasks. The following pattern of results was consistent: On bridge-related tasks speed and accuracy increased with skill level, whereas speed declined only with age for the translation of card symbols to points. There was no relation between bridge expertise and performance on non-bridge tasks, though performance declined consistently with age for reaction time, memory span, and problem solving. It is argued that acquiring expertise provides efficient procedures for tapping an extensive, though domin-constrained knowledge base. With increasing age, however, the hardware supporting information processing declines in efficiency thereby undermining the speed advantage for efficient procedures. (Chairness, 1985, p. 67).

This hardware-software analogy may, I fear, merely mask our ignorance of such complex tasks as bridge-playing. What are the procedures for tapping an extensive, domain-constrained knowledge base? What are the characteristics of such a knowledge base?

The same apparent paradox and the same kinds of questions arise in a study of skilled typing (Salthouse, 1984). Salthouse studied typists who

ranged in speed from 17 to 104 words per minute, and in age from 19 to 72 years. He found the usual declines in the simple "component" skills that presumably underly typing: "choice RT, rate of tapping, and digit-symbol substitution rate - were all slower with increased age...consistent with the results of many previous studies in the aging literature...nevertheless, the slower performance on those tasks was accompanied by virtually unchanged performance across the adult life span in the rate of typing. Individuals could...differ by between 80 ms and 150 msec in choice RT between age 20 and age 60, and yet the average interkey interval in typing was found to be nearly identical for 60-year old typists compared with 20-year-old typists. A dramatic discrepancy therefore clearly exists between the results f traditional laboratory tasks and the performance of the real-life activity of typing" (p. 368, 369).

There are at least two classes of explanation for this apparent paradox: the absence of any decline, and perhaps even an improvement in complex, task performance that requires expertise, accompanied by declines in what seem to be simpler performances and skills that, one would think, underly the expert performance. The two classes of explanation focus on what might be different sides of the same coin. One class of explanation tries to account for the poor performance on the simple, laboratory tasks by appealing to extraneous factors that artifactually depress performance in older people. One example of this is Adams and Datan's (1985) study of memory decline with age, in which they argue that non-cognitive factors such as motivation, self-esteem and education can account for much of the reported declines. This approach accounts for the paradox of expertise by explaining away the so-called deficits on component skills. Although some of this may be true, I'm inclined to think that age-related deficits in reaction time, tapping rate, and memory are real...for laboratory tasks. If

these deficits are real, then the other class of explanation must be invoked...that expertise does not rely on simple component skills and processes, but in cognitive functioning that we do not yet fully understand. In his typing study, for example, Salthouse suggests that older people compensate for their general slowing down by being more sensitive to characters further in advance f the currently typed character. This seems plausible, but how are they able to do this better than younger typists, given that the older are generally "less capable?" If the older are able to do this, why don't the younger typists do it also?

What these paradoxes tell us is that we haven't really begun to understand complex cognitive functioning. We know a little about the memory processes involved in chess playing both at the novice and master levels. We know a little about the cognitive processes involved in playing bridge, and in skilled typing. We do not know why performances on simple, laboratory tasks decline with age, nor why such declines do not necessarily predict declines in more complex functions.

It is in this respect that aging research has contributed to cognitive psychology in a way that is quite distinct from other "special" populations. Studies of clinical and neurological populations (including aging populations) have traditionally provided theoretically important phenomena, such as the dissociations between long- and short-term memory, that tell us about the nature of memory, or the dissociation between semantic and syntactic functioning that inform us about the nature of language processing. The paradox of expertise tells us something different. It suggests limitations of the componential approach to skilled functioning and it poses an important puzzle - how does expertise work, in each of the many domains that require expertise? This may well be one of the more important areas of research in cognitive psychology in the next few decades: the

analysis of complex, expert performances that are, in Gestalt terms, more than the sum of their parts.

The interesting theoretical question here is: are expert performances maintained by compensatory strategies, or, is our initial componential analysis of such tasks fundamentally wrong? I suspect that compensatory strategies can account for some of the paradox, but I also strongly suspect that our componential analyses of complex tasks are fundamentally inadequate. More is involved in typing than choice reaction time and finger tapping speed, and more must be involved in writing poetry than speed of lexical access and memory retrieval efficiency. Until cognitive psychology becomes more sophisticated in the analyses of such domains, we won't really understand the relation between component processes (such as they are) and the fully integrated expert-level performances that we're ultimately most interested in preserving.

The expertise paradox also has a most important social and political implication. It is certainly true that the measures most commonly used in the psychology of aging show declines with age. But if those measures continue to be of the traditional kind - not requiring expertise, not drawing on the accumulated knowledge and skills of the expert - then those measures are inappropriate to predict continuing performance levels in "real life", i.e., the workplace. We may indeed get slower with age, but perhaps only in those kinds of tasks that don't matter. And if productivity in a given field does seem to decline with age, then perhaps that field doesn't require the kind of expertise required in the arts, literature and the sciences. I trust psychology - of aging and cognitive psychology in general - is more like typing and bridge playing than choice reaction time and finger tapping. But, only time and age will tell.

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